DTU Library

# Improving e-learning by Emotive Feedback

**Sharp, Robin; Gjedde, Lisa**

*Published in:*
Proceedings of the IADIS International Conference on Interfaces and Human Computer Interaction

*Publication date:*
2011

# IMPROVING E-LEARNING BY EMOTIVE FEEDBACK

Robin Sharp
*DTU Informatics*
*Technical University of Denmark, DK-2800 Lyngby, Denmark*

Lisa Gjedde
*Danish School of Education*
*Aarhus University, Tuborgvej 164, DK-2400 Copenhagen NV, Denmark*

**ABSTRACT**

This paper considers the use of feedback with emotive elements in order to improve the efficiency of e-learning for teaching complex technical subjects to the general public by stimulation of implicit learning. An example is presented, based on an effort to investigate the current level of IT security among the general public, together with ways of improving it. We present a model for implicit learning in which interactive learning material is combined with a surveying environment: the user is guided and stimulated to reflect by the questions of the survey and is offered an environment for exploration and reflection that is supported by the feedback offered by the system.

**KEYWORDS**

Interactive learning environment; simulation; implicit learning; affective interfaces.

## 1. INTRODUCTION

In the world of today, ordinary people with no technical training often find themselves obliged to engage in technical activities of which they have no basic understanding. Although the tasks in which they engage may demand a relatively high level of technical skill in order to avoid accidents to persons, to their equipment and other assets, and possibly also to their public reputation, it can be extremely difficult to give them any formal training or education. One important reason for this is that they often perceive themselves as being *dystechnic*, and therefore believe (rightly or wrongly) that they simply lack the ability to learn about technical subjects -- an attitude which makes them very hard to motivate.

A possible approach to improving the level of competence of such people is to stimulate processes of *implicit learning*. This form of learning was first investigated by Reber in 1967, and defined by him as "the acquisition of knowledge that takes place largely independent of conscious attempts to learn and largely in the absence of explicit knowledge of what was acquired" (Reber 1993). Seger has given a major review of this approach (Seger 1994), and characterized it as "learning complex information without complete verbalizable knowledge of what is learned".

A typical strategy for implicit learning is to engage the learners in an inductive learning process based on visual or tactile stimuli, in which they learn through active enquiry and experimentation rather than through more traditional learning techniques which rely on passive reception (Bruner 1973). In many cases, this type of learning process can be supported by computers in an e-learning environment which allows multi-modal presentations and possibilities for enquiry and experimentation in the field concerned. For this to be effective, the interaction between user and computer must be carefully designed to stimulate the implicit learning process. The essential challenge is to induce the user to absorb as much knowledge as possible about the technical area concerned while using as little explicit explanation as possible. The solution which we propose is to use interactive learning materials, in which respondents are placed in a simulated situation which resembles what they would observe in real life, and are asked what they would do in this situation.

Investigations into cognitive science and learning theory have shown that questions play a central role in both explicit and implicit learning. Schank and Cleary (1995), for example, observe that questions "…point to holes in our memory structures that we wish to fill. They provide the starting point for the processes through which we integrate new information into memory, tie old information together in new ways, and correct our faulty generalizations". In the same paper, Schank & Cleary also point out that "an important aspect of learning is simply being able to predict what will happen next, on the basis of experience". This implies that the learners must experience a series of examples and receive adequate relevant feedback on their reactions in order inductively to build up a more correct (conscious or unconscious) mental model. Moreno & Mayer (2007) concluded that guiding of the learner's activity, promotion of reflection by questioning, and provision of feedback all have considerable positive influence on the process of learning and that the cognitive processes involved are influenced by affective elements, as in the attitude systems defined by Zimbardo & Leippe (1991) in relation to the task of changing people's attitudes.

In this paper we present and discuss an innovative e-learning environment which aims at promoting implicit learning by asking respondents to react to simulated situations related to the technical area which is of interest, and giving them immediate feedback on their performance, where the feedback contains affective elements. We report on how respondents reacted to this, and present evidence that this approach is not only attractive to the respondents, but also effective in teaching them appropriate behavior.

## 2. AN INTERFACE FOR IMPLICIT E-LEARNING

As an example we consider an effort to teach ordinary people about IT security, a technological area which many people find hard to understand. Surveys of ordinary IT users, both in industrial and domestic settings, such as (Forrester 2005), have previously revealed that many users have a very limited understanding of the technical terms used in discussing IT security, and these observations were confirmed by our own investigations, as illustrated in Figure 1, which comes from a 2009 survey with 700 adult respondents taken from the general public. In this situation, a learning strategy which does not require

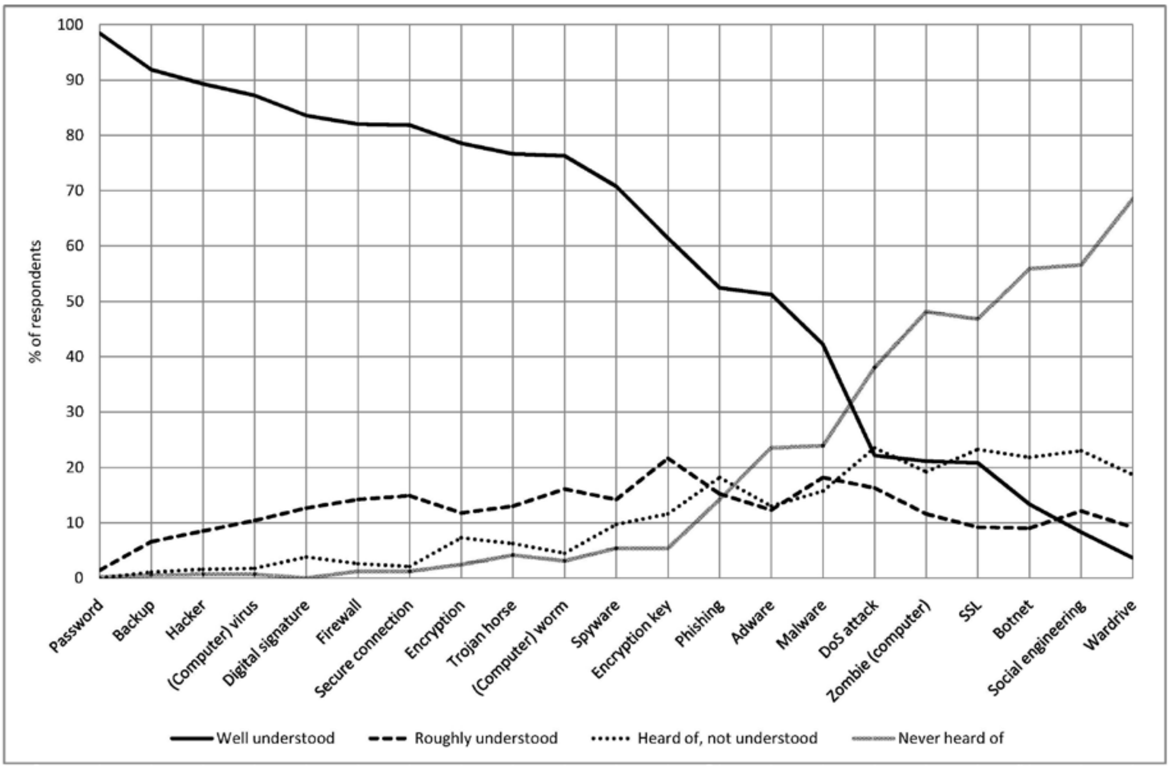


Figure 1: Degree of understanding of some basic IT security concepts

verbalization of knowledge is obviously advantageous. It does not help to explain how to avoid some IT security threat such as "phishing", if the respondents have a completely wrong idea (or even no idea at all) about what phishing is or why it could be a problem for them. To learn, the users have to be placed in a situation in which the abstract, technically formulated threat becomes real to them in some way.

## 2.1 Learning material

In our investigation, we presented the learning material to the learners in the form of a multimodal web-based questionnaire. This contained two types of question:

1. Neutral questions about the respondents' background and pattern of computer usage, with no learning elements.
2. Questions in which the respondents were presented with simulated situations and asked what they would do. These simulated situations used a media-rich presentation with dynamic elements (implemented in Flash), so that the respondent would get the same look and feel as if working at his or her web browser or mail client, and which allowed the respondent to experiment in order to evaluate the situation before answering.

The purpose of this second type of question was to induce implicit learning. To promote this, the respondents received immediate positive or negative feedback, encouraging (or, where appropriate, discouraging) further behavior of the same type in similar situations.

Learning systems with instant feedback are known to be attractive to respondents. The feedback helps to maintain the respondents' interest in working with the system (Moreno & Mayer 2007;Vasilyeva et al. 2007), and indeed the whole success of computer-based instruction is claimed to depend not only on what is presented, but also on the quality and appropriateness of feedback provided to the learners (Mason & Bruning 2009). In our experiments, we made use of two levels of feedback:

- An overall judgement of whether the user's response was good or bad in the given situation. In our case this made use of visual feedback in the form of a little animated figure (a cartoon dog) which could show various emotions, in the form of positive or negative body language, facial expressions and patterns of behaviour.

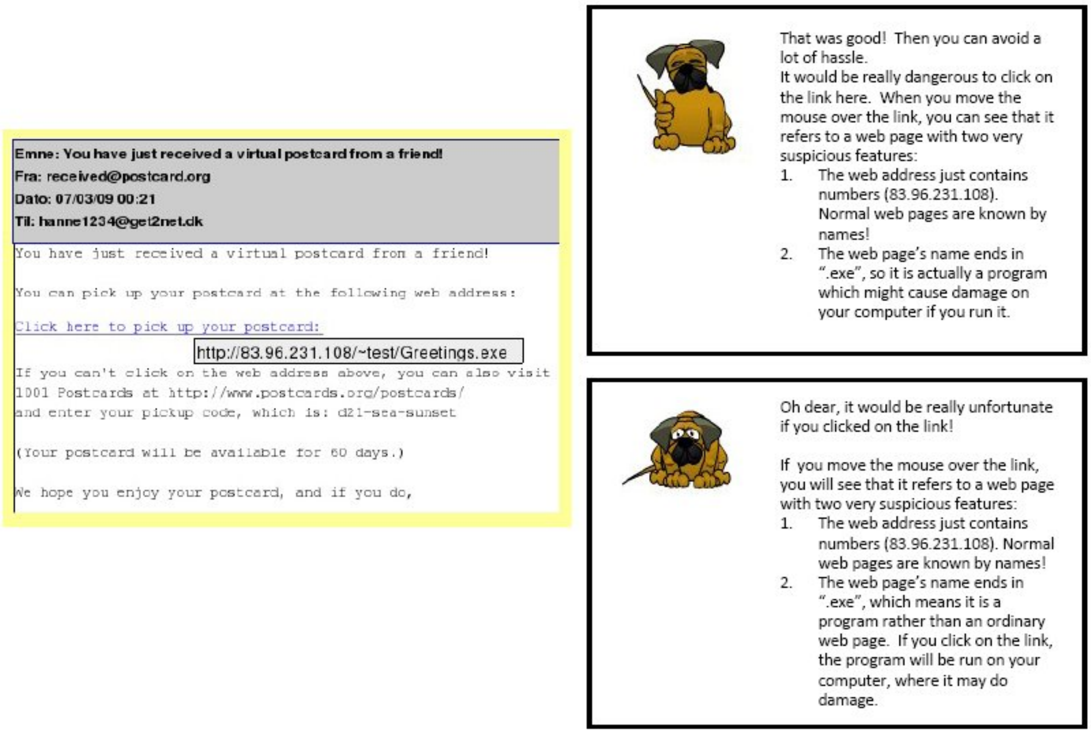

Figure 2: An example of a situation to which users have to respond

- A more detailed, partly technical explanation of what was good and bad and what the user could do in order to react in a more appropriate way. In our case this generally had the form of textual feedback which had to be read and understood in order to have any effect.

An example can be seen in Figure 2. Here, the users are asked whether they would click on the link shown in the left hand "e-mail message". The framed box http://83.96… would in reality only appear when (and if) they move the mouse over the link. The best answer from an IT security point of view is that they should *not* click on the link. If they give this answer, they see the box at the top on the right. If they answer that they *would* click on the link, or answer "don't know", they see the box at the bottom on the right.

This approach is intended to stimulate both implicit and explicit learning, so that different types of respondent can all experience a learning effect. The more detailed explanation appeals to the more technically minded respondents. The visual feedback with the cartoon dog appeals to almost everyone, and stimulates memory without verbalization. The dog can look and act as if afraid/worried, astonished, happy, sad, angry, questioning or encouraging, as well as taking on more neutral attitudes. Most people found the dog empathic – we chose not to use the "angry" dog in these experiments – and, as observed by Martin & Reigeluth (1999), these affective elements maintain the respondent's motivation to continue with the questionnaire.

The rapid feedback is generally strongly appreciated by respondents. In all of our surveys, users were asked to evaluate the technique and a typical response was: "Good to have the correct answer if you answer wrong. This is also part of the motivation, that you during examples can learn something". Despite the fact that the material took the form of a survey questionnaire, several respondents in fact came to consider it as a form of teaching material. As one of the respondents said when the approach was tried out in an industrial company (Pettersson 2009): "It could also be nice to have the survey as a reminder if you later will be in doubt".

## 2.2 Effectiveness of the approach

In technical areas such as the one on which we have focussed, many non-technical learners appear to be able to deal satisfactorily with the technical challenges if they possess enough tacit knowledge. The learning process should therefore be organised in a manner which stimulates the acquisition of tacit knowledge. Reber (1993) has pointed out that, while learning can occur both explicitly and implicitly, there is evidence that complex material may best be learned implicitly. Implicit learning is an inductive learning process, and therefore needs to draw on an experiential approach, where the learner is presented with concrete experiences and based on those is able to build up an internal model of the world which gives meaning (Prince & Felder 2006; Kolb 1984). In our interactive questionnaires, respondents are presented with a variety of related situations which are intended to facilitate this inductive process, and the respondents' feeling that they have

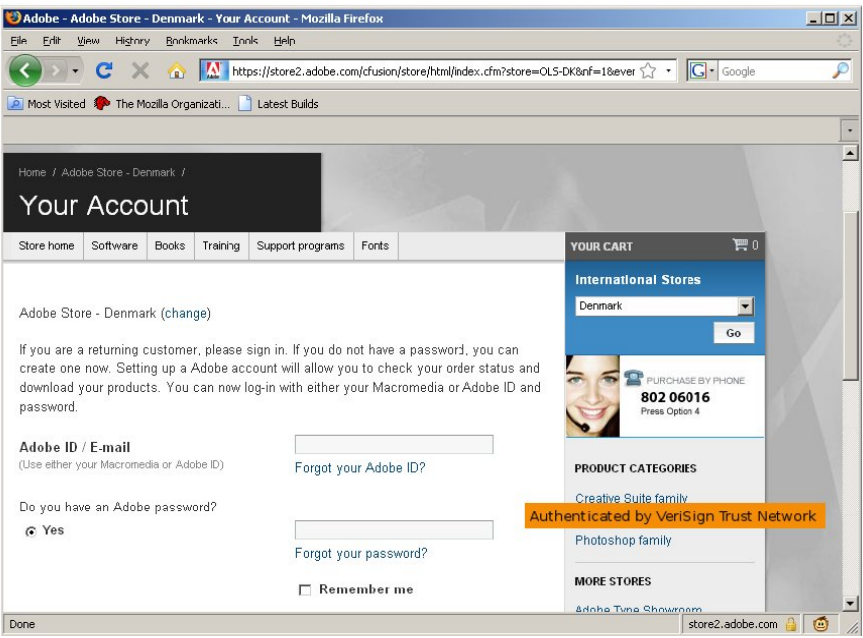

Figure 3: A web page which the respondent should trust

in fact learnt something seems to indicate that this has been successful.

To test whether this feeling has a basis in reality or is merely a positive feeling generated by the emotive feedback, we included in the material a number of series of questions related to the same topic. If the learning effect is real, then we should expect respondents' performance to improve as they answer the questions in a series and receive feedback after each response. One series, for example, dealt with the topic of phishing – attempts by miscreants to trick unsuspecting computer users into revealing personal or confidential information. To perform phishing, the miscreant commonly sends a fake e-mail or sets up a fake web page which resembles one from a trusted party, such as a bank or other financial institution. However, the fake will differ from the genuine web page by lacking one or more of the visual clues in the browser window which indicate the genuine article. Three of the most important of these are firstly that the web address of the web page should start with "**`https:`**", indicating that there is a secure connection through the Internet to the web site, secondly that there should be the address of the website and a small padlock (either at the bottom on the right or just next to the web address), indicating that the origin of the web page has been authenticated, and thirdly that if the mouse is moved over the area with the padlock, then a message appears saying who it is that guarantees the authenticity of the web site.

In the case shown in Figure 3, a respondent who is a secure IT user will realize that all three conditions are satisfied (the orange box appears when the mouse is moved over the padlock area), so the web page can be trusted to be genuine. But it is notoriously difficult, even for experienced users, to keep track of all the necessary indicators (Dhamija et al. 2006), which is why phishing works. In our experiments, respondents were asked to judge the genuineness of a series of 6 web pages, of which some were genuine and others lacked one or more of the indicators, and they were given feedback after each response. The results of this experiment are shown in Figure 4. The diamond-, square- and triangle-shaped data points show the percentage of correct judgements for each question for groups of respondents who rated themselves according to experience as Beginners, Experienced users or Experts respectively. The circular data points show the average over the entire group of 383 respondents. The straight lines are linear regression lines through the data points for the individual groups and for the entire group of respondents. The calculated Pearson correlation coefficients ($r^2$), the corresponding F-values and the probability p(F) that this $r^2$ value is observed by chance – rather than due to a genuine linear correlation between the two variables – can be seen in Table 1, together with the intercepts a and slopes m for the regression lines for the four sets of data.

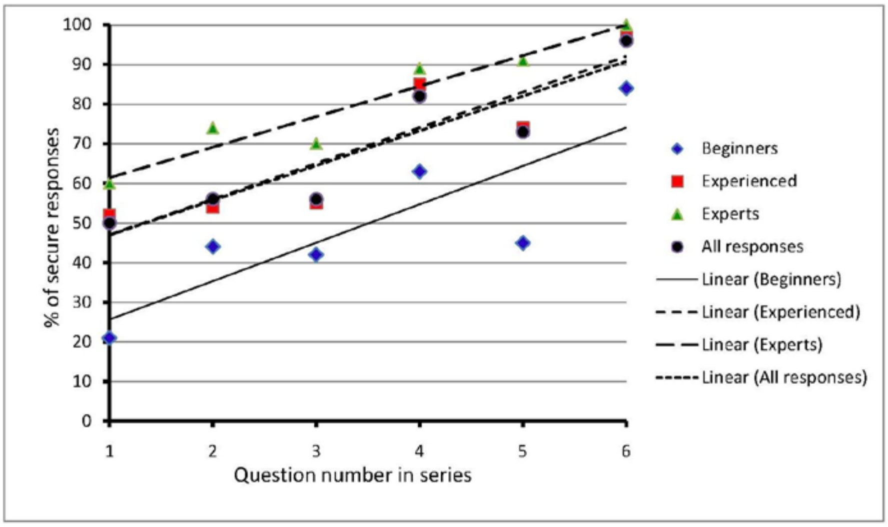


Figure 4: Development in the proportion of secure responses

We see that in all cases there is a low probability that the linear relationship between the proportion of secure responses and position in the series of questions arises by chance. All the regression lines have slopes which are statistically significantly greater than zero ($p(m \leq 0) < 0.05$), indicating that performance improves as respondents progress through the series of questions. There is no statistically significant difference (to the 5% level) between the slopes for the different groups of respondents. However, there is a statistically significant difference between the intercept for respondents with different degrees of experience, reflecting the intuitively obvious fact that more experienced users have a "better" starting point than less experienced ones.

Table 1: Statistical parameters for the regression lines of Figure 4

| | Beginners | Experienced users | Experts | All responses |
|---|---|---|---|---|
| $r^2$ | 0.72 | 0.80 | 0.92 | 0.83 |
| F | 10.1 | 15.9 | 44.4 | 22.2 |
| p(F) | 0.027 | 0.012 | 0.002 | 0.008 |
| Intercept, a | 15.9±11.9 | 38.0±8.8 | 53.7±4.5 | 38.1±7.6 |
| Slope, m | 9.68±3.05 | 9.00±2.25 | 7.71±1.16 | 8.77±1.95 |

# 3. CONCLUSION

This paper has presented some results from a series of e-learning experiments in the area of IT security based on the use of interactive, multimodal questionnaires. In these experiments, users respond by showing how they would react in realistic situations where they can experiment with the environment, and are provided with immediate feedback on the appropriateness (from an IT security point of view) of their responses. The respondents were members of the general public with widely differing technical pre-requisites, ranging from persons with essentially no technical knowledge to persons with considerable knowledge in the field concerned. To cater for all types of respondent, the feedback provided to the respondents consisted of two parts: a non-verbal part with affective elements and a verbal part with more technical comments. This approach is based on a number of studies which indicate that rich media are most likely to transfer tacit knowledge and thus promote implicit learning, whereas word-based representations are most likely to be useful for sharing explicit knowledge and thus promote explicit learning (Daft & Lengel 1986).

Rieber (1996) has found that it should not be assumed that the experimental approach will automatically lead to explicit learning. However, in the area which we have considered, as in many others where there is an element of risk if people behave in an inappropriate manner, it is likely that tacit knowledge is adequate to protect the general public against the most prevalent dangers. Campaigns and methods of instruction which promote implicit learning (possibly at the expense of explicit learning) are therefore more likely to succeed.

Although our experiments have been concentrated in the area of IT security, the basic technique seems applicable to other technical areas that are difficult for the uninitiated learner to approach. We have found that the combination of immediate feedback and simulated environments offer the learner a motivating experience which most respondents find attractive. The basic mechanism seems to be that it opens the path for further learning by providing a positive experience that in turn helps to modify or adjust the limited self-perception which gets people to consider themselves as dystechnic. Even though we do not claim to cure actual dystechnic tendencies, it is clear from our investigations that this approach stimulates learning for people with a wide range of technical experience, including people who class themselves as beginners, and who must therefore be assumed to have very few technical pre-requisites for understanding verbal technical descriptions. The blurred boundaries between a survey and a media-rich interactive learning environment have engaged the respondents in a learning process which they might otherwise have shied away from.

This approach has further succeeded in eliciting their tacit knowledge about a domain where they have little or no explicit knowledge, and thus a domain that can be difficult to research through verbal questionnaires.

## ACKNOWLEDGEMENTS

This work has been supported by Danish Strategic Research Council as part of the "IT Security for the Citizens" project within the NABIIT research programme. The authors gratefully acknowledge this support.

## REFERENCES

Bruner, J., 1973. *Going Beyond the Information Given*. Norton, New York.

Daft, R.L. & Lengel, R.H., 1986. Organizational information requirements, media richness and structural design. *Management Science,* Vol. 32, No. 5, pp. 554-571.

Dhamija, R., Tygar, J.D. & Hearst, M., 2006. Why phishing works. In R. Grinter et al. (eds.), *CHI2006: Proceedings of SIGCHI Conference on Human Factors in Computing Systems* (pp. 881-590). ACM.

Forrester Custom Consumer Research, 2005. *Understanding consumers' needs for Internet security.* Business Software Association. Retrieved from http://www.bsa.org/country/Research%20and%20Statistics/Research%20Papers.aspx

Kolb, D.A., 1984. Experiential Learning: Experience as the Source of Learning and Development. Prentice-Hall, Inc., Englewood Cliffs, N.J.

Martin, B.L. & Reigeluth, C.M., 1999. Affective Education and the Affective Domain: Implications for Instructional-Design Theories and Models. In C.M. Reigeluth (Ed.): *Instructional-design theories and models, Volume 2* (Chapter 20). Lawrence Erlbaum Ass. Publishers, Mahwah, NJ.

Mason, B.J. & Bruning, R., 2009. *Providing feedback in computer-based instruction: What the research tells us.* Retrieved from http://dwb.unl.edu/Edit/MB/MasonBruning.html, August 2009.

Moreno, R. & Mayer, R., 2007. Interactive Multimodal Learning Environments. *Educational Psychological Review*, Vol. 19, pp. 309-326.

Pettersson, J.M., 2009. *The Safe and Secure Mobile Employee.* M.Sc. thesis IMM-M.Sc.-2009-33. DTU Informatics, Technical University of Denmark.

Prince, M.J. & Felder, R.M., 2006. Inductive Teaching and Learning Methods: Definitions, Comparisons and Research Bases. *J. Engineering Education*, Vol. 95, No. 2, pp. 123–138.

Reber, A.S., 1993. *Implicit Learning and Tacit Knowledge.* Oxford Psychology Series, Oxford University Press.

Rieber, L.P., 1996. Animation as feedback in computer-based simulation – Representation matters. *Educational Technology, Research and Development*, Vol. 44, pp. 5-22.

Schank, R.C. & Cleary, C., 1995. *Engines for Education* (pp. 95-105). Lawrence Erlbaum Ass. Publishers, Hillsdale NJ.

Seger, C.A., 1994. Implicit learning. *Psychological Bulletin*, Vol. 115, No. 2, pp. 163-196.

Vasilyeva, E.,Puuronen, S., Pechenizkiy, M. & Räsänen, P., 2007. Feedback adaptation in web-based applications, *Intl. J. Continuing Engineering Education and Life-Long Learning*, Vol. 17, Nos. 4-5, pp. 337–357.

Zimbardo, P.G. & Leippe, M.R., 1991. *The Psychology of Attitude Change and Social Influence.* McGraw-Hill, New York.